Title: Method and Apparatus for Power Management of an Electronic Device

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Cross Reference to Related Applications

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Field of the Invention

The present invention relates to a method and an apparatus for power management of an electronic device.

Background of the Invention

Mobile electronic devices for accessing wireless network is becoming more and more popular, but the power consumption of devices with built-in wireless network function is high, and thus shortens the operation time of mobile electronic devices using batteries for power supply. Several methods for power management of an electronic device are provided in U.S. Patent No. US 6330462 B1, US 6236674 B1, US 6489725 B1, etc. A communication system disclosed in US 6330462 B1 manages power by changing a rate of transmitting data. The system includes a transmitter and a receiver. Firstly, the transmitter is operated at an idle rate. Next, the transmitter sends a notice to the receiver when the transmitter receives the data to be transmitted at a high rate. Finally, the transmitter transmits the data to the receiver at a high rate. The method described in US 6236674 B1 manages power by mode switching. The transmitter and the receiver can switch between a low-consumption mode and an active mode, and a control circuit controls the switch according to the data detected to be received. The receiver of the method also can include a circuit detecting the strength of the signal to be received. The circuit can disable the receiver circuit when the detected strength of the data to

be received is smaller than a predetermined value. The method of US 6489725 B1 uses a power saving circuit to save standby power of electronic devices. A capacitor is connected to an AC power supply, and a phase-leading current component passing the capacitor is used to make a DC power supply supplying power during standby. In case an infrared command is used, the capacitor is connected in parallel to another capacitor to strengthen the current output capability of the DC power supply, having an AC switching element maintained in on mode.

However, power consumption for the abovementioned designs is high, and a method and an apparatus for power management to save more power is needed.

Summary of the Invention

Therefore, one purpose of the present invention is to provide a method and an apparatus for power management of an electronic device. The method and the apparatus can monitor the state of data transfer of the electric device and control the electric power according to the user's setting to save power.

The spirit of the present invention lies in its deciding the power mode according to the monitored state of data transfer of the electronic device so as to save power.

A method and an apparatus for power management of an electronic device are provided. The electronic device has a first power mode and a second power mode, and may be in a first operation state or a second operation state.

First method for power management

The method for the present invention includes the following steps. A sampling time span including a plurality of sampling time units is set. The operation state of the electronic device during each sampling time unit is decided. The ratio of sampling time units, in which the electronic device is at the first operation state, in the sampling time span is calculated. The power mode of the electronic device is determined according to the ratio. When the ratio is larger than a predetermined value, the electronic device is switched to the first power mode. When the ratio is smaller than the predetermined value, the electronic device is switched to the

second power mode.

The above-mentioned steps of determining operation state of each sampling time unit further include the following steps. An accumulated quantity of transferred data is calculated at the beginning of one sampling time unit. A temporary accumulated quantity of transferred data is calculated at the end of the sampling time unit. The temporary accumulated quantity of transferred data is compared with the accumulated quantity of transferred data. When the temporary accumulated quantity of transferred data equals the accumulated quantity of transferred data, the operation state for this sampling time unit is categorized to be at a first operation state.

The first power mode can be an off mode and the second power mode can be an on mode, and the electronic device can be set in the second power mode at the beginning. The first operation state can be an idle state and the second operation state can be an active state, but is not limited thereto. A user can decide the sampling time. The user can also determine the length of each sampling time unit. When the first operation state is an idle state and the first power mode is an off mode, the above-mentioned predetermined value can be set to be between 0.8 and 1, but is not limited thereto.

Second method for power management

The method according to another aspect of the present invention includes the following steps. A sampling time span including a plurality of sampling time units is set. The operation state of the electronic device during each sampling time unit is decided. The number of sampling time units during which the device is in the first operation state in this sampling time span is calculated. The power mode of the electronic device is determined according to the number. When the number is larger than a predetermined number, the electronic device is switched to the first power mode. When the number is smaller than the predetermined number, the electronic device is switched to the second power mode.

The above-mentioned steps of determining operation state of each sampling time unit further includes the following steps. An accumulated quantity of transferred data is calculated

at the beginning of one sampling time unit. A temporary accumulated quantity of transferred data is calculated at the end of the sampling time unit. The temporary accumulated quantity of transferred data is compared with the accumulated quantity of transferred data. When the temporary accumulated quantity of transferred data equals the accumulated quantity of transferred data, the operation state for this sampling time unit is categorized to be at a first operation state.

The first power mode can be an off mode and the second power mode can be an on mode, and so the electronic device can be set in the second power mode at the beginning. The first operation state can be an idle state and the second operation state can be an active state, but is not limited thereto. The sampling time span can also be determined by the user, such as for 10 minutes, but it is not limited thereto. The length of each sampling time unit can also be determined by the user, such as 5 seconds, but is not limited thereto.

First power management device

A power management device of the present invention includes a setup unit, a state determination unit, a calculation unit, and a decision unit. The setup unit sets up a sampling time span including a plurality of sampling time units. The state determination unit determines the operation state of the electronic device at each sampling time unit according to the operation of the electronic device at each sampling time unit. The ratio of sampling time units, in which the electronic device is at the first operation state, in the sampling time span is calculated by the calculation unit. A decision unit operates the electronic device in either the first or the second power mode according to the ratio. When the ratio is larger than a predetermined value, the electronic device is switched to the first power mode. When the ratio is smaller than the predetermined value, the electronic device is switched to the second power mode.

The above-mentioned state determination unit further has a first calculation unit, a second calculation unit, and a check unit. The first calculation unit calculates an accumulated quantity of transferred data at the beginning of one sampling time unit. The second

calculation unit calculates a temporary accumulated quantity of transferred data at the end of the sampling time unit. The check unit checks whether the temporary accumulated quantity of transferred data equals the accumulated quantity of transferred data. When the temporary accumulated quantity of transferred data equals the accumulated quantity of transferred data, the operation state for this sampling time unit is categorized to be at a first operation state.

The first power mode can be an off mode and the second power mode can be an on mode, and the power mode of the electronic device is in the second power mode at the beginning. The first operation state can be an idle state and the second operation state can be an active state, but is not limited thereto. A user can decide the above-mentioned sampling time span as, such as 10 minutes, but it is not limited thereto. The length of each sampling time unit can also be determined by the user, such as 5 seconds, but is not limited thereto. When the first operation state is an idle state and the first power mode is an off mode, the above-mentioned predetermined value can be set to be between 0.8 and 1, but is not limited thereto.

Second power management device

A power management device of the present invention includes a setup unit, a state determination unit, a calculation unit, and a decision unit. The setup unit sets up a sampling time span including a plurality of sampling time units. The state determination unit determines the operation state of the electronic device at each sampling time unit according to operation of the electronic device at each sampling time unit. The number of sampling time units, in which the electronic device is at the first operation state, in the sampling time span is calculated by the calculation unit. A decision unit operates the electronic device in either the first or the second power mode according to the number. When the number is larger than a predetermined number, the electronic device is switched to the first power mode; when the number is smaller than the predetermined number, the electronic device is switched to the second power mode.

The above-mentioned state determination unit further has a first calculation unit, a second calculation unit, and a check unit. The first calculation unit calculates an accumulated

quantity of the transferred data at the beginning of one sampling time unit. The second calculation unit calculates a temporary accumulated quantity of the transferred data at the end of the sampling time unit. The check unit checks whether the temporary accumulated quantity of transferred data equals the accumulated quantity of transferred data. When the temporary accumulated quantity of transferred data equals to the accumulated quantity of transferred data, the operation state for this sampling time unit is categorized to be at a first operation state..

The first power mode can be an off mode and the second power mode can be an on mode when the power mode of the electronic device is in the second power mode at the beginning. The first operation state can be an idle state and the second operation state can be an active state, but is not limited thereto. A user can decide the above-mentioned sampling time span as, such as 10 minutes, but it is not limited thereto. The length of sampling time unit can be determined by the user, such as 5 seconds, but not limited thereto. When the first operation state is an idle state and the first power mode is an off mode, the above-mentioned predetermined value can be set to be between 0.8 and 1, but is not limited thereto.

Brief Description of the Drawings

For a more complete understanding of the present invention, reference is now made to the following descriptions taken in conjunction with the accompanying drawings.

Fig. 1 is a flow diagram of a first embodiment according to the method of the present invention;

Fig. 2 is a flow diagram of a second embodiment according to the method of the present invention;

Fig. 3 is a schematic diagram of deciding the operation state according to the method of the embodiment of the present invention;

Fig. 4 is a schematic diagram of the first embodiment according to the apparatus of the present invention; and

Fig. 5 is a schematic diagram of the second embodiment according to apparatus of the present invention.

Detailed Description

A method and an apparatus for power management of an electronic device are provided. The electronic device has a first and a second power mode, and may be in a first or a second operation state.

Method for power management of the first embodiment

Fig. 1 and Fig. 3 explain the method for power management of the first embodiment of the present invention. In this embodiment, the first power mode is an off mode and the second power mode is an on mode, and the electronic device is in the second power mode at the beginning. In addition, the first operation state is an idle state and the second operation state is an active state.

In step 102, a sampling time span **W** including a plurality of sampling time units $\mathbf{T_i}$ is set according to a use's preference, such as 10 minutes. The length of the sampling time unit $\mathbf{T_i}$ can also be determined by the user, here the length of Ti is 1 minute for this embodiment. As shown in Fig. 3, the sampling time span **W** includes ten sampling time units $\mathbf{T_1}$~$\mathbf{T_{10}}$ in the first embodiment.

Next, the operation state of each sampling time unit Ti is decided. In step 104, an accumulated quantity of transferred data $\mathbf{ATB_i}$ is calculated at the beginning of one sampling time unit $\mathbf{T_i}$. A temporary accumulated quantity of transferred data $\mathbf{TATB_i}$ is calculated at the end of the sampling time unit. As shown in Fig. 3, $\mathbf{ATB_5}$ is 3 at $\mathbf{T_5}$ and $\mathbf{TATB_5}$ is 4 at $\mathbf{T_5}$. However, $\mathbf{ATB_{10}}$ is 4 at $\mathbf{T_{10}}$ and $\mathbf{TATB_{10}}$ is 4 at $\mathbf{T_{10}}$. Checking whether the temporary accumulated quantity of transferred data $\mathbf{TATB_i}$ equals the accumulated quantity of transferred data $\mathbf{ATB_i}$ is subsequently performed in step **106**. The second operation state as being the operation state of the electronic device during the sampling time unit $\mathbf{T_i}$ is decided in step **108** when the temporary accumulated quantity of transferred data $\mathbf{TATB_i}$ does not equal the accumulated quantity of transferred data $\mathbf{ATB_i}$. For example, as $\mathbf{ATB_5} \neq \mathbf{TATB_5}$, $\mathbf{T_5}$ is in second operation state, which is an active state in the present invention. In step **108**, i is set as

i+1 and step **104** is repeated to decide the operation state of the next sampling time unit T_i.

In step **110**, the first operation state as being the operation state of the electronic device during the sampling unit $\mathbf{T_i}$ is decided when the temporary accumulated quantity of transferred data $\mathbf{TATB_i}$ equals the accumulated quantity of transferred data $\mathbf{ATB_i}$. For example, as $\mathbf{ATB_{10}} = \mathbf{TATB_{10}}$, $\mathbf{T_{10}}$ is in the second operation state, which is an idle state in the present invention. In step **110** i is set as i+1 to process the next step. A ratio $\mathbf{R_I}$ of a time sum when the electronic device is in the first operation state of the sampling time unit over the sampling time span **W** is calculated (step **112**). For example, $\mathbf{R_I}$ is calculated as $\mathbf{T_{10}}$ is in the first operation state. The electronic device is in the first operation state in 9 out of 10 sampling time units, so the ratio $\mathbf{R_I}$ equals 0.9.

In step **114**, whether the ratio $\mathbf{R_I}$ is larger than the predetermined value $\mathbf{R_S}$ is decided to determine the power mode of the electronic device. The predetermined value $\mathbf{R_S}$ is 0.85 when the first operation state is an idle state and the first power mode is an off mode as in the present embodiment. If the ratio $\mathbf{R_I}$ is larger than the predetermined value $\mathbf{R_S}$, the electronic device is in the first power mode (step **116**). The first power mode of the present embodiment is an off mode. For example, the power of the electronic device will be in an off mode achieving the power-saving effect when $\mathbf{R_I}$ (=0.9) is larger than $\mathbf{R_S}$ (=0.85) at the end of $\mathbf{T_{10}}$.

A user can manually start the power of the electronic device again after the power of the present embodiment is turned off, or the electronic device can be started automatically and remain in the second power mode before transferring data again.

The electronic device will be in a second power mode and step **104** will be repeated if the ratio $\mathbf{R_I}$ is smaller than the predetermined value $\mathbf{R_S}$. The second power mode of the present embodiment is an on mode. For example, because $\mathbf{TATB_8}$ equals $\mathbf{ATB_8}$ and the electronic device is in the first operation state at $\mathbf{T_8}$, $\mathbf{R_I}$ needs to be calculated. The electronic device is in the first operation state in 7 out of 10 sampling time units, so that ratio $\mathbf{R_I}$ equals 0.7. Since $\mathbf{R_I}$ (= 0.7) is smaller than the predetermined value $\mathbf{R_S}$ (= 0.85), the electronic device will remain in an on mode and step **104** will be repeated.

Method for power management of the second embodiment

Fig. 2 and Fig. 3 explain the method for power management of the second embodiment of the present invention. In this embodiment, the first power mode is an off mode and the second power mode is an on mode, and also the power mode of the electronic device is in the second power mode at the beginning. In addition, the first operation state is an idle state and the second operation state is an active state. Steps **202~210** are similar to steps **102~110** of the method for power management of the first embodiment.

In step the 212 of the second embodiment. As the electronic device is in the first operation state, the number N_1 of the sampling time unit T_i when the electronic devices in the first operation state in a sampling span **W** is calculated. For example, N_1 is calculated as T_{10} is in the first operation state. At 9 of the sampling time units, the electronic device is in the first operation state, so N_1 equals 9.

In step **214,** whether the number N_1 is larger than the predetermined number N_s is decided to determine the power mode of the electronic device. The predetermined value N_s can be 8 when the first operation state is an idle state and the first power mode is an off mode as in the present embodiment. In step **216,** if the number N_1 is larger than the predetermined number **N,** the electronic device is in the first power mode. The first power mode of the present embodiment is an off mode. For example, the power of the electronic device will be in an off mode achieving the power-saving effect when N_1 **(=9)** is larger than N_s (=8) at the end of T_{10}.

A user can manually start the power of the electronic device again after the power of the present embodiment is turned off, or the electronic device can be started automatically and remain in the second power mode before transferring data again.

The electronic device will be in a second power mode and step **204** will be repeated if the number N_1 is smaller than the predetermined number N_s. The second power mode of the present embodiment is an on mode. For example, because $TATB_8$ equals ATB_8 and the electronic device is in the first operation at T_8, N_1 needs to be calculated. The electronic device is in the first operation state in 7 out of 10 sampling time units, so N_1 equals 7. Since N_1 (=7) is smaller than the predetermined value N_s (=8), the electronic device will remains in

an on mode and step **204** will be repeated.

First embodiment of the apparatus for power management

A method and an apparatus for power management of an electronic device are provided. The electronic device has a first and a second power mode, and may be in a first or a second operation state. Fig. 4 explains the first embodiment **400** of the apparatus for power management of the present invention. The device for power management of the embodiment includes a setup unit **402**, a state determination unit **404**, a memory and calculation unit **406**, an calculation unit **408** and a decision unit **410**. Setup unit **402** sets up a sampling time span including a plurality of sampling time units. Data of the sampling time span and the sampling time units are transferred to state determination unit **404**. The state determination unit **404** determines the operation state of the electronic device at each time sampling unit according to the operation of the electronic device at each sampling time unit. Data about the operation of the electronic device at each sampling time unit are transferred to a memory and calculation unit **406**. The memory and calculation unit **406** stores the data of the operation state at each sampling time unit, and sets i as i+1 to process the next sampling time unit. The calculation unit **408** calculates a ratio of a time sum under the first operation state over the sampling time span. The ratio is transferred to the decision unit **410**. The decision unit **410** decides to operate the electronic device in either the first or the second power mode according to the ratio. When the ratio is larger than a predetermined value, the electronic device is switched to the first power mode; when the ratio is smaller than the predetermined value, the electronic device is switched to the second power mode.

The state determination unit **404** further includes a first calculation unit **4042**, a second calculation unit **4044**, and a check unit **4046**. The first calculation unit **4042** calculates an accumulated quantity of transferred data at the beginning of one sampling time unit. The second calculation unit calculates a temporary accumulated quantity of transferred data at the end of the sampling time unit. The check unit checks whether the temporary accumulated quantity of transferred data equals the accumulated quantity of transferred data. The first

operation state as being the operation state of the electronic device during the sampling time unit is decided when the temporary accumulated quantity of transferred data equals the accumulated quantity of transferred data.

The first power mode can be an off mode and the second power mode can be an on mode. In this case, the electronic device is in the second power mode at the beginning as in embodiment **400**, but is not limited thereto. The first operation state can be an idle state and the second operation state can be an active state, but are not limited thereto. A user can decide the above-mentioned sampling time span as, for example, 10 minutes, but it is not limited thereto. The length of each sampling time unit is arbitrary, such as 5 seconds. When the first operation state is an idle state and the first power mode is an off mode, the above-mentioned predetermined value is neither smaller than 0.8 nor larger than 1.

Second embodiment of the apparatus for power management

Fig. 5 explains the second embodiment **500** of the apparatus for power management of the present invention. Elements **502** and **5042~5046** of the apparatus for power management of the second embodiment **500** correspond to elements **402** and **4042~4046** of the apparatus for power management of the first embodiment **400**. An calculation unit **508** of the present embodiment **500** calculates number of the first operation state during the sampling time span. A decision unit **510** decides to operate the electronic device in either the first or the second power mode according to the number. When the number is larger than a predetermined value, the electronic device is switched to the first power mode; when the number is smaller than the predetermined value, the electronic device is switched to the second power mode.

The first power mode can be an off mode and the second power mode can be an on mode. In this case, the electronic device is in the second power mode at the beginning as in embodiment **500**, but is not limited thereto. The first operation state can be an idle state and the second operation state can be an active state, but are not limited thereto. A user can decide the above-mentioned sampling time span as, for example, 10 minutes, but it is not limited thereto. The length of each sampling time unit is arbitrary, such as 5 seconds.

In addition to the first power mode and the second power mode, the electronic apparatus can also be switched to a third power mode. The third power mode is a power-saving mode and consumes power by an amount between the first and the second power modes. The electronic device is switched between the second and the third power modes when connected to an external power source. The electronic device is switched between the first, the second, and/or the third power modes when it is powered by a battery.

While this invention has been described with reference to the illustrative embodiments, these descriptions should not be construed in a limiting sense. For example, the time units and sampling time spans can be different, and the power mode is not limited to two or three types. Various modifications of the illustrative embodiment, as well as other embodiments of the invention, will be apparent upon reference to these descriptions. It is therefore contemplated that the appended claims will cover any such modifications or embodiments as falling within the true scope of the invention and its legal equivalents.